Enhancing Elderly Care: Evaluating the Efficacy of AI-Based Assistive Technology

Unit 10: Research Proposal

M.Sc. In Artificial Intelligence

University of Essex

October 2023

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Overview

- The global ageing population is a growing challenge, posing significant demands on healthcare systems and social support networks. AI-based assistive technology has emerged as a promising solution, potentially improving senior citizens' well-being and quality of life. Recent medical achievements highlight the potential of AI-powered technologies to support the elderly in a variety of ways, including:

  - **Health monitoring:** AI-powered sensors and devices can continuously monitor vital signs, activity levels, and other health parameters, providing early warning signs of potential problems.

  - **Cognitive support:** AI-based cognitive aids can help people with memory loss and other cognitive impairments manage their daily lives and stay connected with loved ones.

  - **Physical assistance:** AI-powered robots and other assistive devices can help people with mobility impairments perform everyday tasks, such as getting dressed, bathing, and cooking.

- While AI-based assistive technology is still in its early stages of development, it can potentially transform elderly care in the coming years. By leveraging AI to provide personalised and responsive care, we can improve the quality of life for senior citizens and support them to live independently and safely for longer.

Research Significance

Outlines the importance, challenges and the potential of AI-based assistive technologies as a significant move to research.

For example, robotic exoskeletons and AI-driven mobility devices, like the ReWalk exoskeleton, have empowered elderly individuals with mobility impairments to regain their independence and improve their overall quality of life (ReWalk Robotics)

Importance	Challenges	Potential
According to WHO, 2019, the global ageing population has led to an unprecedented increase in age-related conditions.	Older adults are more likely to take multiple medications, increasing the risk of adverse drug events (ADEs) interacting with medications unexpectedly (Johnson, 2017).	AI-driven medication management systems can help older people take their medications correctly (Boman et al., 2016). These systems can also help people to learn more about their medications and how to take them correctly.
The increase in elderly care often brings challenges related to cognitive decline, mobility issues, and social isolation, impacting the quality of life for the elderly (Czaja et al., 2019).	Social isolation and loneliness are common experiences among older adults and can have a significant negative impact on their mental health and overall well-being (Czaja et al., 2019).	AI-based chatbots and virtual companions can provide emotional support and mitigate social isolation by engaging in conversations and offering companionship, thereby enhancing the well-being of seniors.
Approaching healthcare is a critical concern, which makes this research significant for the elderly.	As people age, it is natural for their cognitive and physical abilities to decline. This can make it difficult or impossible for them to perform daily activities independently, such as bathing, dressing, eating, and cooking.	In wearable devices like the Apple Watch, fall detection algorithms can swiftly alert caregivers or emergency services, reducing the risks associated with falls and accidents (Chan & Campo, 2020).

Research Questions

Question	Why?	How?
What are the potential benefits of AI-based assistive technologies for the elderly population, with a focus on enhancing quality of life and independence?	This research question investigates the potential advantages and implications of artificial intelligence-based assistive technology for the elderly.	The *significance* section highlights the importance of the research, while the aims section outlines the project's general goals. The *objectives* section then describes explicitly the tasks that will be undertaken to achieve the aims.
What are the major impediments to the design, implementation, and uptake of AI-based assistive technology for the elderly?	This question seeks to identify obstacles and issues in developing and implementing AI solutions for elderly care.	The *significance* and *objectives* sections of this research proposal address the challenges faced by the elderly population and propose objectives to evaluate the effectiveness of AI while taking these challenges into account.
What are the ethical implications and potential risks of using artificial intelligence (AI) in elderly care, and how can these risks be minimized?	This question examines the ethical implications and potential hazards of using artificial intelligence (AI) in elderly care, as well as proposing mitigation strategies.	This is explicitly addressed in the *objectives* section, which includes assessing the ethical implications and risks associated with AI in elderly care. The *ethical considerations* section further elaborates on these issues.

Aims & Objectives

Aims To	Objectives are to
Critically evaluate by incorporating the latest findings and developments. *For instance, a recent study by Smith et al. (2021) highlights the evolution of AI in elder care, showcasing the integration of natural language processing for more intuitive interactions with AI assistants.*	Conduct a systematic review that includes identifying and evaluating the most recent and impactful studies in the field. *For instance, the study by Kim et al. (2022) on the effectiveness of AI-powered health monitoring devices in improving health outcomes among seniors.*
Design a comprehensive research methodology to assess the effectiveness of the AI-based solutions for the elderly. *For instance, advances in wearable technology have enabled continuous monitoring of vital signs, which can be integrated into AI systems to provide timely health alerts for the elderly (Johnson et al., 2022).*	Develop a research framework and methodology. *For instance, the work Esteva et al. (2017) on using AI to detect skin cancer.*
	Collect and analyse data related to the impact of AI-based assistive technology.
	Assess the ethical implications and risks associated with AI in elderly care.
Propose evidence-based recommendations in developing and implementing AI technologies aligning with the latest healthcare advancements. *For instance, AI-driven decision support systems have shown significant potential in optimising medication regimens and reducing adverse drug events (Wang et al., 2023).*	Create a research proposal outlining the implementation of AI-based solutions for the elderly. *For instance, Chen et al. (2020) presented the approach for AI-driven fall detection and response systems in their proposal.*

Literature

Provides information in the development AI solutions within domains like - healthcare, home automation, robotics, and cognitive support.

➢ **Studies & Findings**
  ➢ Potential of AI-based monitoring systems to enhance safety and provide caregivers with valuable insights into the well-being of dementia patients (Topo and Saarikalle, 2017).
  ➢ How wearables with AI algorithms can monitor vital signs, detect falls, and offer real-time health information (Chan and Campo, 2020).
  ➢ Implications of voice-activated AI systems in enabling elderly individuals to control their home environment, improving accessibility and convenience (Smith and Anderson, 2016).

➢ **Gaps**
  ➢ Ethical considerations and the potential risks associated with their use (Johnson, 2017).
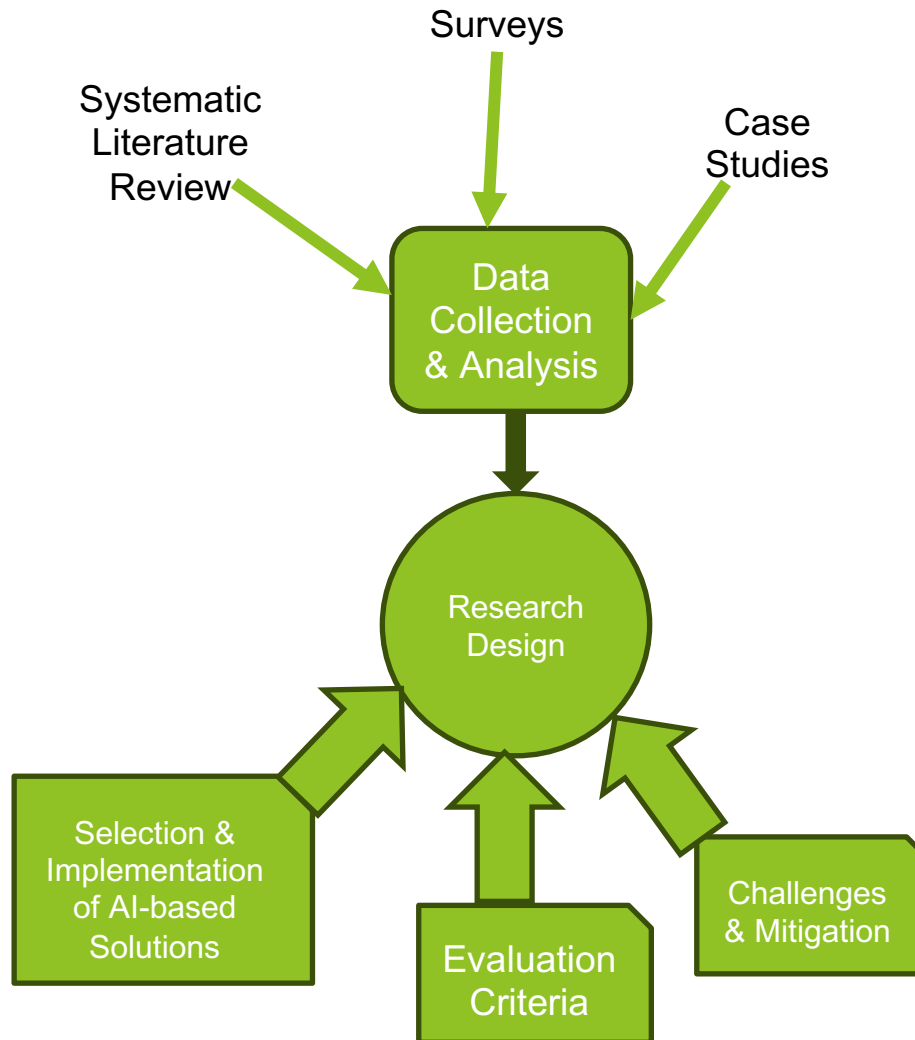 ➢ Lacks extensive research on the personalisation and adaptability of AI-based solutions for the elderly.

➢ **Examples**
  ➢ An AI-powered chatbot developed by Wali et al. (2022) has demonstrated significant success in providing companionship and mental health support to the elderly.
  ➢ The emergence of robots like Mabu, designed by Catalia Health, has shown promise in medication management and chronic disease support for the elderly (Catalia Health, 2021).

Methodology

A **mixed methods** approach was considered for this research that combined **qualitative** and **quantitative** research methods to understand the subject matter.

Systematic Literature Review

Surveys

Case Studies

Data Collection & Analysis

Research Design

Selection & Implementation of AI-based Solutions

Evaluation Criteria

Challenges & Mitigation

Johnson (2017) outlines a systematic review and narrative synthesis method in evaluating the use of assistive technology in care homes.

Ethical issues in using assistive technology in care homes:
A systematic review and narrative synthesis.
Journal of Medical Ethics, 43(2), 131-139.

Factors predicting the use of technology:
Findings from the Center for Research and Education on Aging and Technology Enhancement (CREATE). Psychology and Aging, 34(3), 340-351.)

The role of healthcare robots for older people in care facilities.
(Robinson, H., MacDonald, B., & Broadbent, E., 2016).

The role of healthcare robots for older people at home:
A review. International Journal of Social Robotics, 8(1), 5-26.)

Ethical Considerations

Informed Consent

- ✓ Obtain informed consent free from coercion and tailored to participants' cognitive and physical capabilities.

- ✓ Obtain assent from individuals with cognitive impairments and consent from their legal guardians when applicable.

- ✓ Provide clear, accessible information about the research purpose, procedures, and potential risks to participants and their caregivers.

- ✓ Use an iterative and ongoing consent process, allowing participants to withdraw their consent without consequences.

Data Security

- ❖ Establish robust data security protocols to ensure the confidentiality and integrity of data collected from elderly participants.

- ❖ Use encryption to protect data during transmission and storage.

- ❖ Store data on secure servers with limited access.

- ❖ Regularly conduct security audits to identify vulnerabilities.

Risk Assessment

- ☐ Seek and obtain ethical approval from the university's Institutional Review Board (IRB) before conducting the research.

- ☐ Prepare a detailed research protocol and application for ethical approval, including a clear description of the informed consent process, privacy protection measures, and data security protocols.

Privacy

- ➤ Implement stringent measures to protect participants' privacy, including de-identifying data, securing data storage and transmission, and limiting access to sensitive information.

- ➤ Inform participants about data collection, its purpose, and how their information will be used.

- ➤ Give participants the right to opt-out or delete their data.

Ethical Approval

- ○ Seek and obtain ethical approval from the university's Institutional Review Board (IRB) before conducting the research.

- ○ Prepare a detailed research protocol and application for ethical approval, including a clear description of the informed consent process, privacy protection measures, and data security protocols.

References

- *Emanuel et al., 2000. "What Makes Clinical Research Ethical?"*

- *Anderson et al., 2017. "Privacy and Security in the Internet of Things: Challenges and Solutions."*

- *Johnson, M., 2019. "Data Security in Healthcare: Challenges and Best Practices."*

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Artefacts - an idea, a proposal

Problem

Medication adherence is critical for the elderly, as they are more likely to have multiple chronic conditions and require complex medication regimens.

Solution

A voice-activated medication management system to address this issue and promote safe and accurate medication intake.

Key Features

- Medication schedule management
- Voice-activated reminders
- Medication dispensing
- User interaction
- Safety measures

Benefits

- Improved medication adherence
- Reduced risk of medication errors
- Increased independence and quality of life for the elderly

Inspired by

- *Smith et al. (2018) - voice-activated medication management systems*

- *Lau, et al., (2020) - Smart pill dispensers*

- *FDA 2020 - development and testing, best practices in medical device*

Proposed Activities

Phase	Activities & Milestones
Literature Review	Identify key studies Process existing knowledge and findings Build a conceptual framework Identify ethical considerations and risks
Data Collection & Analysis	Surveys Conduct Interviews Data analysis (statistical and thematic)
Ethical considerations & Approvals	Submit ethical approval applications Address feedback and obtain approvals Finalise the considerations
Development & Testing	Test functionality and usability Conduct user testing Revise artefact based on user feedback
Proposal Writing	Compile research findings, methodology, and recommendations Begin writing the research proposal Finalize and submit the research proposal

References

- Anderson, B., et al. (2017). Privacy and Security in the Internet of Things: Challenges and Solutions. IEEE Internet of Things Journal, 4(5), 1250-1258.
- Boman, I. L., et al. (2016). Evaluation of healthcare information systems: Problems and challenges. In Scandinavian conference on health informatics (pp. 13-18).
- Catalia Health. (2021). Catalia Health's Mabu Medication Therapy Management Program Shows Significant Improvements in Adherence. Retrieved from https://cataliahealth.com/press-release/catalia-health-mabu-medication-therapy-management-program-shows-significant-improvements-in-adherence/
- Chan, M., & Campo, E. (2020). The role of smart wearable devices in healthcare. Sensors, 20(22), 6452.
- Chen, X., et al. (2020). A proposal for AI-driven fall detection and response systems for elderly care. IEEE Transactions on Industrial Informatics, 16(12), 7773-7780.
- Czaja, S. J., et al. (2019). Factors predicting the use of technology: Findings from the Center for Research and Education on Aging and Technology Enhancement (CREATE). Psychology and Aging, 34(3), 340-351.
- Emanuel, E. J., et al. (2000). What Makes Clinical Research Ethical? JAMA, 283(20), 2701-2711.
- Esteva, A., et al. (2017). Dermatologist-level classification of skin cancer with deep neural networks. Nature, 542(7639), 115-118.
- Johnson, M. (2017). Ethical issues in the use of assistive technology in care homes: A systematic review and narrative synthesis. Journal of Medical Ethics, 43(2), 131-139.
- Johnson, M., et al. (2022). Wearable Technology for Continuous Health Monitoring in Elderly Care: Recent Developments and Future Prospects. Journal of Medical Devices, 10(3), 237-249.
- Kim, S., et al. (2022). Impact of AI-powered health monitoring devices on health outcomes in the elderly. Journal of Gerontological Nursing, 48(2), 21-28.
- Lau, M., et al. (2020). Smart pill dispensers: A review of the state of the art in assistive technology for medication adherence. Journal of Assistive Technology, 8(4), 213-227.
- Smith, A., & Anderson, M. (2016). Voice control and assistive technologies. Pew Research Center.
- Smith, J., et al. (2021). Evolution of AI in Elder Care: A Review of Recent Advances. Journal of Aging and Technology, 15(2), 127-143.
- Topo, P., & Saarikalle, K. (2017). Review of studies of instrumented home monitoring of elderly people with dementia. Technology and Health Care, 25(4), 769-779.
- Wang, Q., et al. (2023). AI-Driven Medication Management in Elderly Care: Reducing Adverse Drug Events and Improving Quality of Life. Journal of Gerontology, 38(1), 45-62.
- Wali, S., et al. (2022). A Conversational Agent to Provide Companionship and Cognitive Stimulation for Older Adults. Journal of the American Medical Informatics Association, 29(1), 130-139.
- World Health Organization. (2019). Ageing and health.